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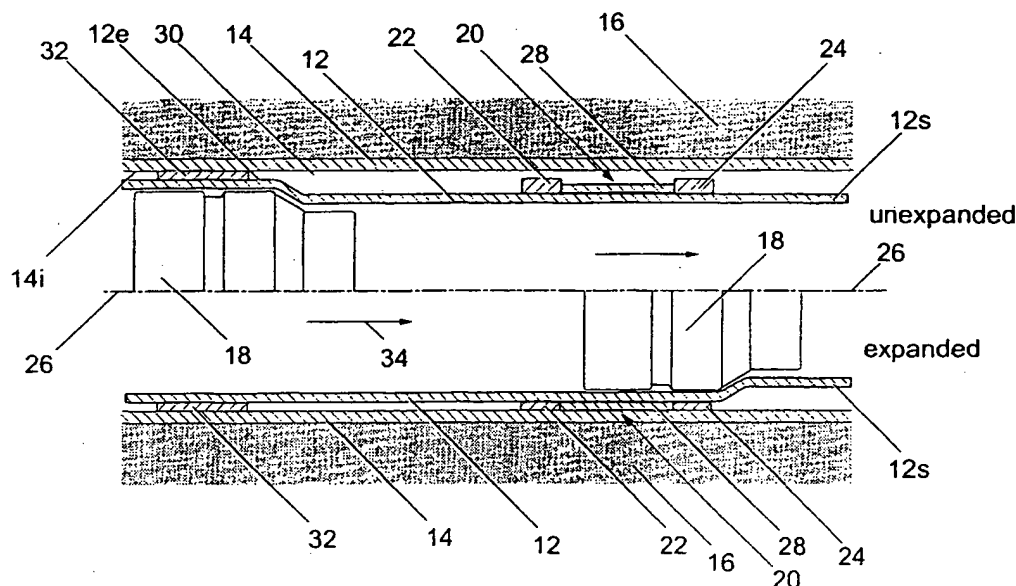
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(54) Title: APPARATUS FOR AND A METHOD OF ANCHORING AN EXPANDABLE CONDUIT



(57) Abstract: The present invention provides apparatus and a method of anchoring an expandable conduit. A formation is provided on an outer surface of the conduit, the formation comprising a number of bands of a friction and/or sealing material. When the expandable conduit is radially expanded, the friction and/or sealing material engages a second conduit in which the expandable conduit is located. The engagement of the friction and/or sealing material provides an anchor for the expandable conduit.

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1 casing contacts the formation around the borehole. The  
2 pliable casing undergoes plastic deformation when  
3 expanded, typically by passing an expander device, such  
4 as a ceramic or steel cone or the like, through the  
5 casing. The expander device is propelled along the  
6 casing in a similar manner to a pipeline pig and may be  
7 pushed (using fluid pressure for example) or pulled  
8 (using drill pipe, rods, coiled tubing, a wireline or  
9 the like).

10

11 Lengths of expandable casing are coupled together  
12 (typically by threaded couplings) to produce a casing  
13 string. The casing string is inserted into the  
14 borehole in an unexpanded state and is subsequently  
15 expanded using the expander device. However, the  
16 unexpanded casing string requires to be anchored either  
17 at an upper end or a lower end thereof before and/or  
18 during the expansion process.

19

20 According to a first aspect of the present invention,  
21 there is provided apparatus for anchoring an expandable  
22 conduit, the apparatus comprising at least one  
23 formation provided on an outer surface of the  
24 expandable conduit, the formation being capable of  
25 engaging a second conduit in which the expandable  
26 conduit is located, the formation providing an anchor  
27 and/or seal for the expandable conduit when the  
28 expandable conduit is at least partially expanded.

29

30 According to a second aspect of the present invention,  
31 there is provided a method of anchoring an expandable  
32 conduit, the method comprising the steps of providing

1 a 40 durometer rubber. The bands of rubber can be of  
2 any suitable hardness and width. Alternatively, the  
3 first rubber can be a 90 durometer rubber, and the  
4 second rubber can be a 60 durometer rubber.

5

6 In an alternative embodiment, the formation comprises a  
7 band of rubber or other suitable resilient material.  
8 The band preferably defines a zigzag pattern on the  
9 outer surface of the conduit. The rubber can be of any  
10 suitable hardness, but is typically in the order of 40  
11 to 90 durometers, although values of hardness outwith  
12 this range may also be used.

13

14 The material properties and configuration of the or  
15 each formation can be chosen to suit the particular  
16 application.

17

18 The expandable conduit typically comprises an  
19 expandable casing or liner. However, the expandable  
20 conduit may be any suitable expandable pipe or the  
21 like.

22

23 The formation is optionally detachable and preferably  
24 applied to the outer surface of the conduit before the  
25 conduit is expanded. The formation optionally  
26 comprises two or more axially spaced formations.

27

28 The second conduit typically comprises a borehole,  
29 casing, liner or the like. The expandable casing may  
30 engage any type of conduit.

31

1 an expandable conduit to a borehole having a  
2 different formation on an outer surface;  
3 Fig. 4a is a front elevation of the formation of  
4 Fig. 3; and  
5 Fig. 4b is an end elevation of the formation of  
6 Fig. 4a.

7  
8 Referring to the drawing, Fig. 1 shows an exemplary  
9 embodiment of apparatus for anchoring an expandable  
10 conduit 12. The expandable conduit 12 is shown located  
11 within a casing or liner 14. Conventionally, casing or  
12 liner 14 is used to line or case a borehole that is  
13 drilled into a formation 16 to facilitate the recovery  
14 of hydrocarbons. It should be noted however, that the  
15 expandable conduit 12 may be a liner or casing used to  
16 case or line the borehole.

17  
18 The expandable conduit 12 may be any type of suitable  
19 conduit that is capable of sustaining plastic  
20 deformation whereby it can be radially expanded by at  
21 least 10%, although it may be radially expanded by a  
22 value more or less than this.

23  
24 The upper portion of Fig. 1 shows the expandable  
25 conduit 12 in unexpanded form, with an expander device  
26 18 located therein used to impart a radial expansion  
27 force. The lower portion of Fig. 1 shows a portion of  
28 the expandable conduit 12 radially expanded by the  
29 expander device 18.

30  
31 The expander device 18 typically comprises a cone. The  
32 expander device 18 may be manufactured from steel, or

1 The first and second bands 22, 24 are typically of a  
2 first depth. The third band 28 is typically of a  
3 second depth. The first depth is typically larger than  
4 the second depth, although they may be the same. Thus,  
5 the first and second bands 22, 24 protrude further from  
6 the surface 12s than the third band 28, as shown  
7 schematically in Fig. 1.

8  
9 The first type of rubber (i.e. first and second bands  
10 22, 24) is preferably of a harder consistency than the  
11 second type of rubber (ie third band 28). The first  
12 type of rubber is typically 60 durometer rubber,  
13 whereas the second type of rubber is typically 40  
14 durometer rubber. Durometer is a conventional hardness  
15 scale for rubber.

16  
17 The particular properties of the rubber may be of any  
18 suitable type and the hardnessess quoted are exemplary  
19 only. It should also be noted that the relative  
20 dimensions and spacings of the first, second and third  
21 bands 22, 24, 28 are exemplary only and may be of any  
22 suitable dimensions and spacing.

23  
24 Referring to Figs 2a to 2c, there is shown an  
25 alternative formation 50 that is substantially the same  
26 as formation 20. In the embodiment shown in Figs 2a to  
27 2c, the formation 50 comprises first and second bands  
28 52, 54 of a first resilient material, with a third band  
29 56 of a second resilient material located therebetween.

30  
31 The first and second bands 52, 54 are around 1 inch  
32 (approximately 25.4mm) wide, and are spaced-apart by

1 apart locations along the length of the expandable  
2 conduit 12, the spacings and number of formations 20,  
3 50 being chosen to suit the particular application.

4  
5 The expandable conduit 12 is then run into a borehole,  
6 casing or liner 14, or some other conduit onto which  
7 the expandable conduit 12 is to be attached. As can be  
8 seen in Fig. 1 (upper portion) when the expandable  
9 conduit 12 is run into the casing or liner 14, an  
10 annulus 30 is created between the outer surface 12s of  
11 the expandable conduit 12 and an inner surface 14i of  
12 the casing or liner 14. The expander device 18 is  
13 typically located in an expanded portion 12e of the  
14 expandable conduit 12 before the conduit 12 is run into  
15 the casing or liner 14. It should be noted that the  
16 conduit 12 is of the non-interference type wherein the  
17 annulus 30 remains (although reduced in size) even when  
18 the expandable conduit 12 is radially expanded ie there  
19 is a gap between the expandable conduit 12 and the  
20 casing or liner 14. Expandable conduit 12 need not be  
21 of the non-interference type.

22  
23 As the outer surface 12s of the expandable conduit 12  
24 is not in direct contact with the inner surface 14i of  
25 the casing or liner 14, a mechanical or other type of  
26 anchoring device 32 (e.g. a slip) is used to provide a  
27 temporary anchor whilst at least a portion of the  
28 expandable conduit 12 is radially expanded. The  
29 mechanical or other type of anchoring device 32 may be  
30 of any conventional type and is typically attached at,  
31 or near, the expanded portion 12e of the expandable  
32 conduit 12.

1 anchors the expandable conduit 12 to the casing or  
2 liner 14.

3  
4 Additionally, the first and/or second rubbers may also  
5 act as a seal that results in an annular pressure seal  
6 that seals the annulus 30. Where two or more  
7 formations 20, 50 are provided at axially spaced-apart  
8 locations, the portions of the annulus 30 between the  
9 formations 20, 50 will be isolated from one another.

10  
11 After the formation 20, 50 has been expanded whereby  
12 the first and second rubbers provide at least an anchor  
13 point for the expandable casing 12 (and optionally a  
14 seal for annulus 30), the mechanical or other type of  
15 anchoring device 32 can be released, and optionally  
16 removed from the casing or liner 14.

17  
18 Referring to Fig. 3, there is shown an alternative  
19 expandable conduit 100, that is a second embodiment of  
20 apparatus of the present invention. Expandable conduit  
21 100 is substantially the same as expandable conduit 12,  
22 but has a further alternative formation 150 on an outer  
23 surface 100s thereof.

24  
25 The expandable conduit 100 may be any type of suitable  
26 conduit that is capable of sustaining plastic  
27 deformation whereby it can be radially expanded by at  
28 least 10%, although it may be radially expanded by a  
29 value more or less than this.

30  
31 As can be seen from Fig. 3, the expandable conduit 100  
32 is provided with a pre-expanded portion 100e in which



1 18° between each along one edge 150a of the band. The  
2 process is then repeated by milling another 20 slots  
3 152b on the other side 150b of the band, the slots on  
4 the other side being circumferentially offset by 9°  
5 from the slots 152a on the other side.

6  
7 In use, the formation 150 is applied to the outer  
8 surface 100s of the (unexpanded) expandable conduit  
9 100. The formation 150 may be applied at axially  
10 spaced-apart locations along the length of the  
11 expandable conduit 100, as shown in Fig. 3, the  
12 spacings and number of formations 100 being chosen to  
13 suit the particular application.

14  
15 The expandable conduit 100 is then run into a borehole,  
16 casing or liner 14, or some other conduit onto which  
17 the expandable conduit 100 is to be attached, and is  
18 used in substantially the same way as conduit 12  
19 described above.

20  
21 Using the method and apparatus described herein for  
22 anchoring an expandable conduit to a second conduit, it  
23 is possible to case a wellbore using an expandable  
24 conduit provided with the formation, without the use of  
25 cement. This has significant advantages, particularly  
26 in terms of cost due to the reduction of materials  
27 required and rig down-time.

28  
29 Thus, there is provided a method and apparatus of  
30 anchoring an expandable conduit to a second conduit.  
31 Certain embodiments of the apparatus and method  
32 optionally provide a seal between the expandable

## 1 CLAIMS

2 1. Apparatus for anchoring an expandable conduit, the  
3 apparatus comprising at least one formation provided on  
4 an outer surface of the expandable conduit, the  
5 formation being capable of engaging a second conduit in  
6 which the expandable conduit is located, the formation  
7 providing an anchor and/or seal for the expandable  
8 conduit when the expandable conduit is at least  
9 partially expanded.

10

11 2. Apparatus according to claim 1, wherein the  
12 formation comprises resilient material.

13

14 3. Apparatus according to claim 1 or claim 2, wherein  
15 the formation comprises first and second bands of a  
16 first resilient material.

17

18 4. Apparatus according to claim 3, wherein the first  
19 and second bands are axially spaced-apart, with a third  
20 band of a second resilient material being located  
21 between the first and second bands.

22

23 5. Apparatus according to claim 4, wherein the first  
24 resilient material is harder than the second resilient  
25 material.

26

27 6. Apparatus according to claim 4 or claim 5, wherein  
28 the first and/or second resilient materials are  
29 profiled on an outer surface thereof to enhance  
30 anchoring and/or sealing.

31

1

2 15. An expandable conduit according to claim 14,  
3 wherein the first and second bands are axially spaced-  
4 apart, with a third band of a second resilient material  
5 being located between the first and second bands.

6

7 16. An expandable conduit according to claim 15,  
8 wherein the first resilient material is harder than the  
9 second resilient material.

10

11 17. An expandable conduit according to claim 15 or  
12 claim 16, wherein the first and/or second resilient  
13 materials are profiled on an outer surface thereof to  
14 enhance anchoring and/or sealing.

15

16 18. An expandable conduit according to any one of  
17 claims 15 to 17, wherein the first resilient material  
18 comprises a first rubber, and the second resilient  
19 material comprises a second rubber.

20

21 19. Apparatus according to claim 12 or claim 13,  
22 wherein the formation comprises a band of resilient  
23 material that defines a zigzag pattern on an outer  
24 surface of the conduit.

25

26 20. An expandable conduit according to any one of  
27 claims 12 to 19, wherein the formation is applied to  
28 the outer surface of the conduit before the conduit is  
29 expanded.

30

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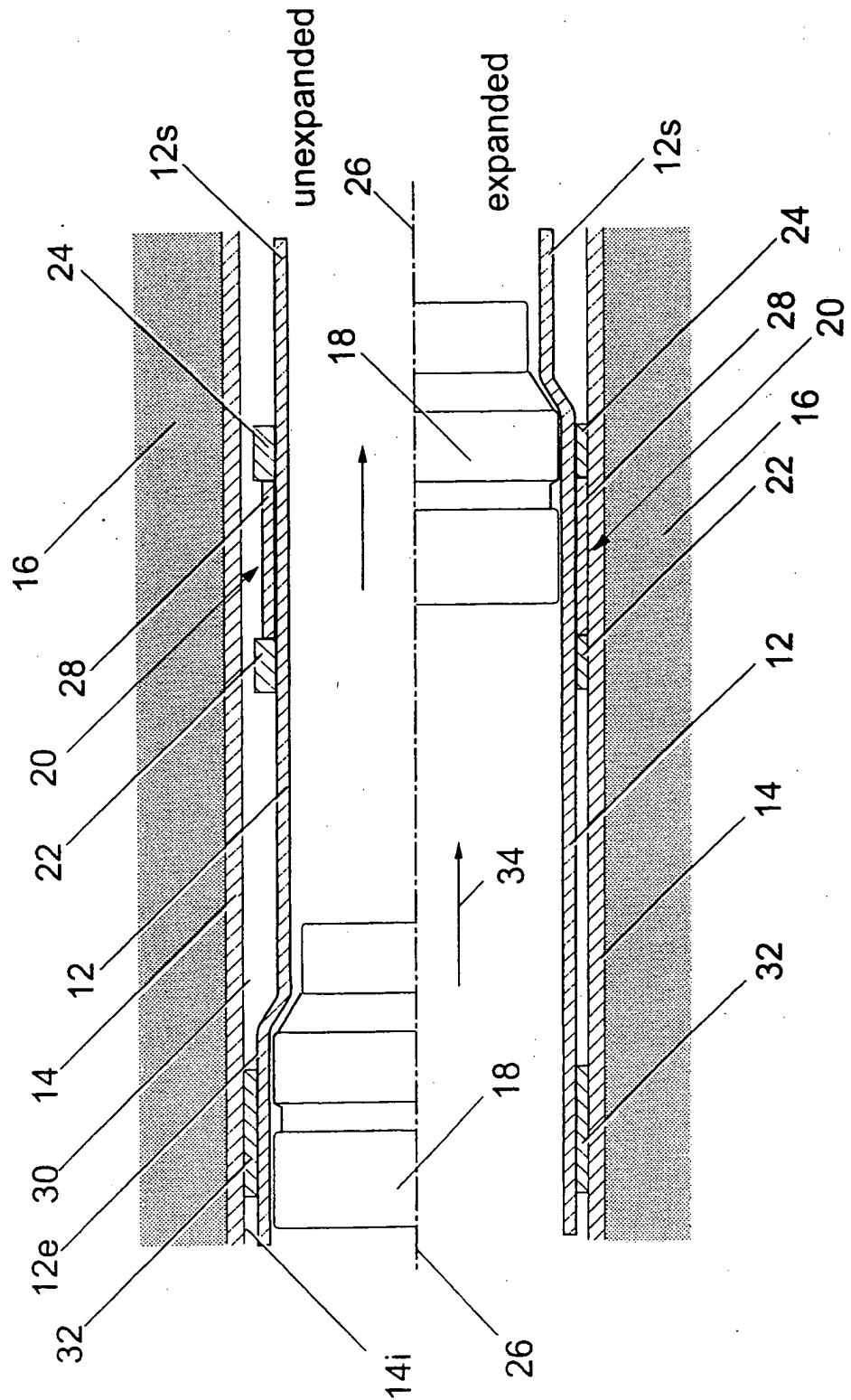
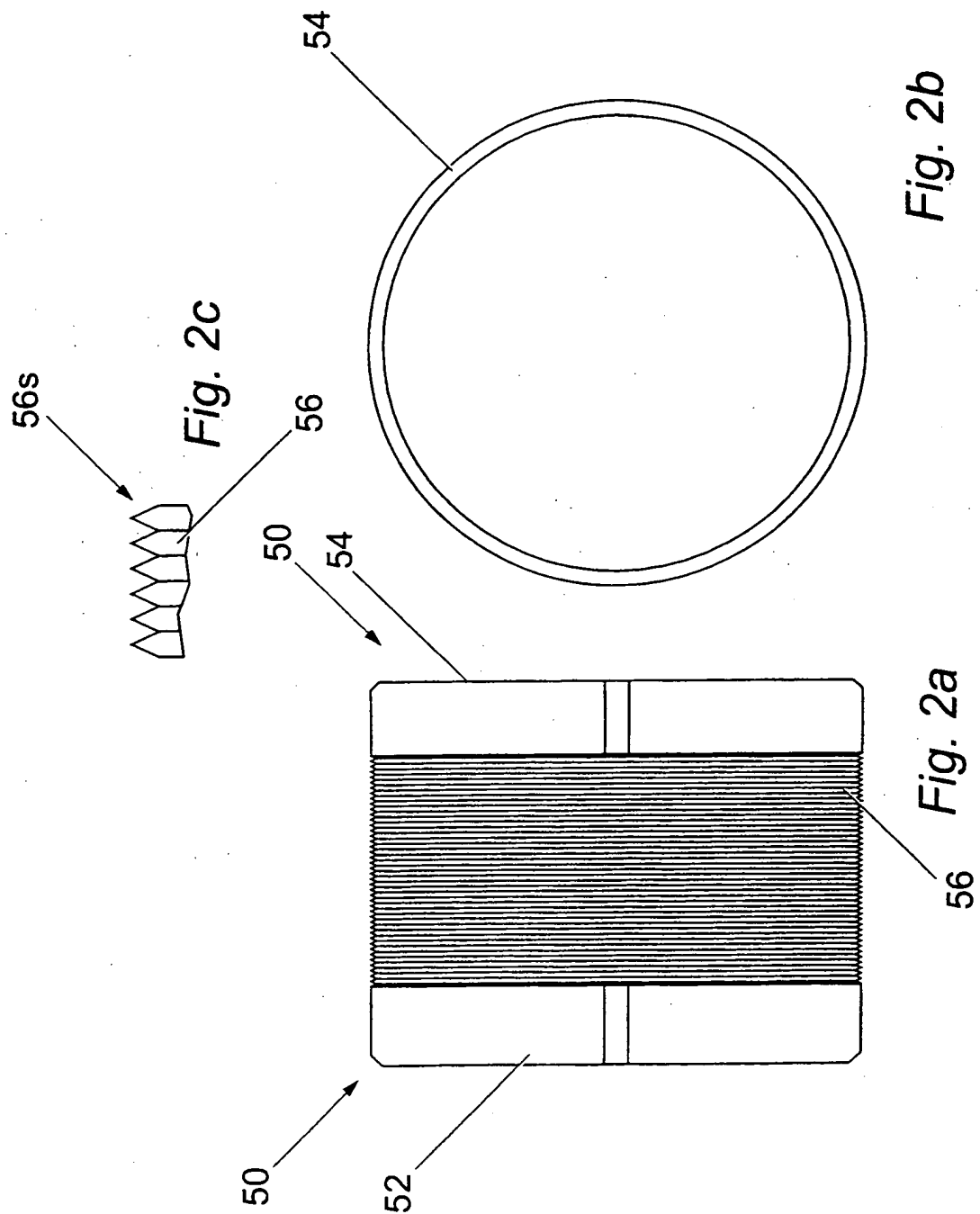


Fig. 1

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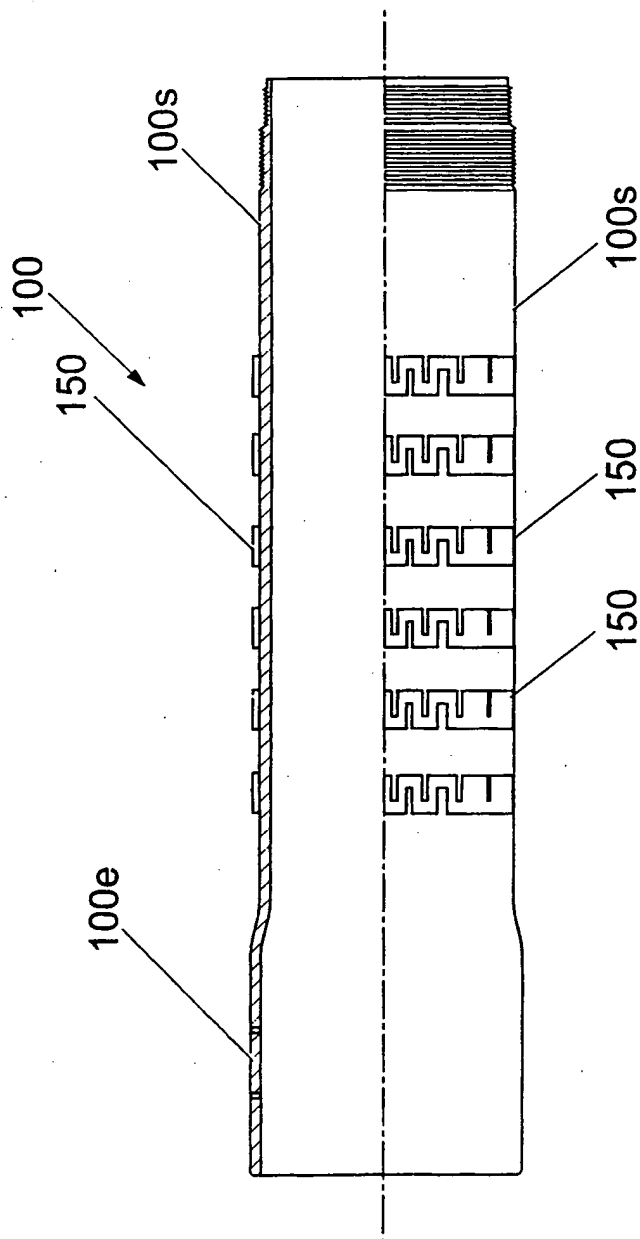


Fig. 3

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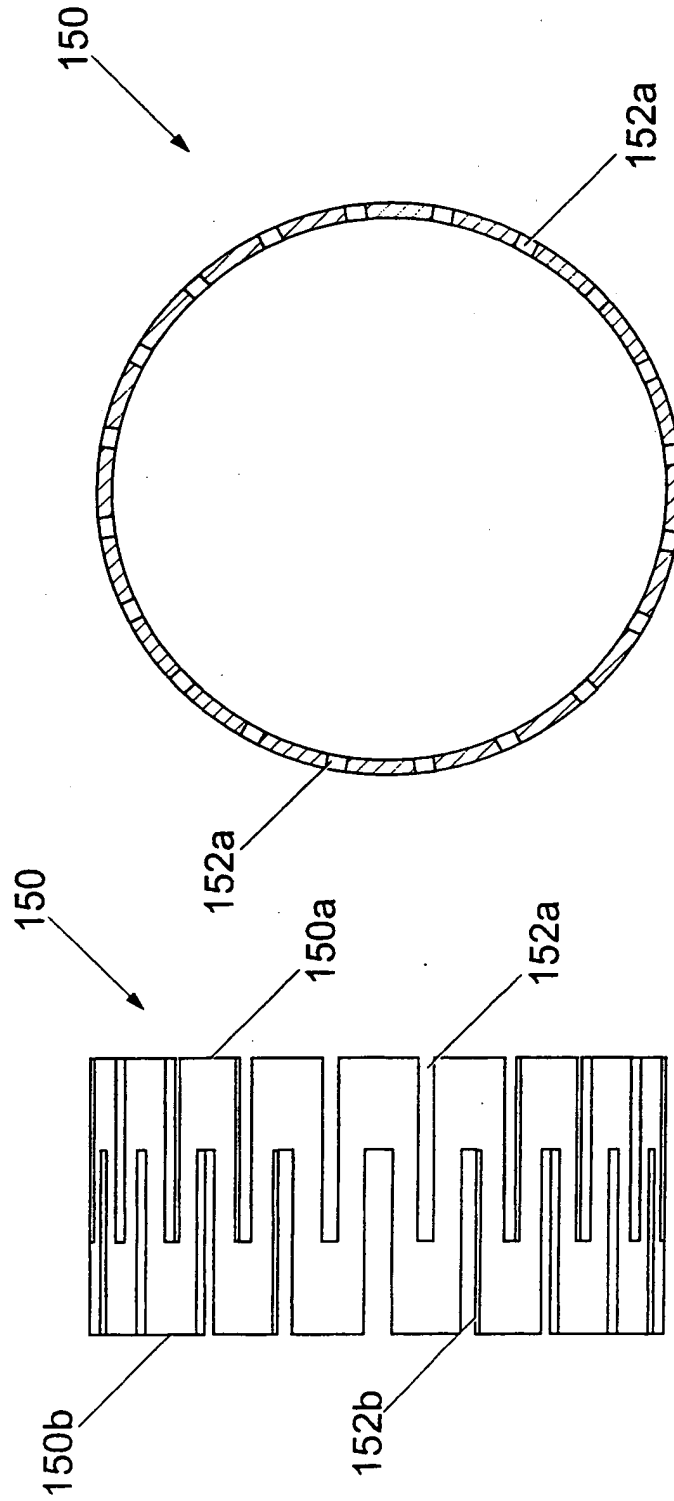


Fig. 4a

Fig. 4b

# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/GB 00/03407

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 7 E21B43/10

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 776 307 A (YOUNG J) 4 December 1973 (1973-12-04)  column 7, line 59 -column 8, line 17 figures 2,4	1-4,7,9, 10, 12-15, 18,20, 21,23,24
X	EP 0 881 354 A (SOFITECH NV ;SCHLUMBERGER CIE DOWELL (FR)) 2 December 1998 (1998-12-02)  page 4, column 5, line 33-35 figure 2	1-4,7,9, 10, 12-15, 18,20,21

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

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Patent document cited in search report		Publication date	Patent family member(s)	Publication date
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